OIPE JC16
JAN 03 2005
PATENT & TRADEMARK OFFICE

IFW

PTO/SB/21 (09-04)
Approved for use through 07/31/2006.
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

TRANSMITTAL FORM

(to be used for all correspondence after initial filing)

Total Number of Pages in This Submission

Application Number	10/663,458
Filing Date	September 15, 2003
First Named Inventor	Valentino Campagnolo
Art Unit	3682
Examiner Name	Marcus Charles
Attorney Docket Number	CAM3-PT023.1

ENCLOSURES *(Check all that apply)*

- [X] Fee Transmittal Form
  - [X] Fee Attached
- [X] Amendment/Reply
  - [ ] After Final
  - [ ] Affidavits/declaration(s)
- [ ] Extension of Time Request
- [ ] Express Abandonment Request
- [ ] Information Disclosure Statement
- [ ] Certified Copy of Priority Document(s)
- [ ] Reply to Missing Parts/ Incomplete Application
  - [ ] Reply to Missing Parts under 37 CFR 1.52 or 1.53
- [X] Drawing(s)
- [ ] Licensing-related Papers
- [ ] Petition
- [ ] Petition to Convert to a Provisional Application
- [ ] Power of Attorney, Revocation Change of Correspondence Address
- [X] Terminal Disclaimer
- [ ] Request for Refund
- [ ] CD, Number of CD(s) _____
  - [ ] Landscape Table on CD
- [ ] After Allowance Communication to TC
- [ ] Appeal Communication to Board of Appeals and Interferences
- [ ] Appeal Communication to TC **(Appeal Notice, Brief, Reply Brief)**
- [ ] Proprietary Information
- [ ] Status Letter
- [X] Other Enclosure(s) (please Identify below):

"Sensors and Transducers Internet Web Page Printout (3 pgs.)"

Remarks

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm Name	VOLPE AND KOENIG, P.C.		
Signature	Stephen B. Schott		
Printed name	Stephen B. Schott		
Date	12/29/2004	Reg. No.	51,294

CERTIFICATE OF TRANSMISSION/MAILING

I hereby certify that this correspondence is being facsimile transmitted to the USPTO or deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date shown below:

Signature	Stephen B. Schott		
Typed or printed name	Stephen B. Schott	Date	12/29/2004

This collection of information is required by 37 CFR 1.5. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and1.14. This collection is estimated to 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

JAN 03 2005
PATENT & TRADEMARK OFFICE

PTO/SB/17 (12-04)
Approved for use through 07/31/2006.
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995 no persons are required to respond to a collection of information unless it displays a valid OMB control number

Effective on 12/08/2004.
Fees pursuant to the Consolidated Appropriations Act, 2005 (H.R. 4818).

FEE TRANSMITTAL
For FY 2005

☒ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT ($) 865.00

Complete if Known	
Application Number	10/663,458
Filing Date	September 15, 2003
First Named Inventor	Valentino Campagnolo
Examiner Name	Marcus Charles
Art Unit	3682
Attorney Docket No.	CAM3-PT023.1

METHOD OF PAYMENT (check all that apply)

☐ Check ☒ Credit Card ☐ Money Order ☐ None ☐ Other (please identify): _____

☒ Deposit Account Deposit Account Number: 22-0493 Deposit Account Name: Volpe and Koenig, P.C.

For the above-identified deposit account, the Director is hereby authorized to: (check all that apply)

☐ Charge fee(s) indicated below ☐ Charge fee(s) indicated below, **except for the filing fee**

☒ Charge any additional fee(s) or underpayments of fee(s) under 37 CFR 1.16 and 1.17 ☒ Credit any overpayments

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

FEE CALCULATION

1. BASIC FILING, SEARCH, AND EXAMINATION FEES

Application Type	FILING FEES Fee ($)	FILING FEES Small Entity Fee ($)	SEARCH FEES Fee ($)	SEARCH FEES Small Entity Fee ($)	EXAMINATION FEES Fee ($)	EXAMINATION FEES Small Entity Fee ($)	Fees Paid ($)
Utility	300	150	500	250	200	100	
Design	200	100	100	50	130	65	
Plant	200	100	300	150	160	80	
Reissue	300	150	500	250	600	300	
Provisional	200	100	0	0	0	0	

2. EXCESS CLAIM FEES

Fee Description	Fee ($)	Small Entity Fee ($)
Each claim over 20 or, for Reissues, each claim over 20 and more than in the original patent	50	25
Each independent claim over 3 or, for Reissues, each independent claim more than in the original patent	200	100
Multiple dependent claims	360	180

Total Claims		Extra Claims	Fee ($)	Fee Paid ($)
28	- 20 =	8	x 25.00	= 200.00

HP = highest number of total claims paid for, if greater than 20

Indep. Claims		Extra Claims	Fee ($)	Fee Paid ($)
9	- 3 =	6	x 100.00	= 600.00

HP = highest number of independent claims paid for, if greater than 3

Multiple Dependent Claims Fee ($)	Fee Paid ($)
	0.00

3. APPLICATION SIZE FEE

If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets		Extra Sheets		Number of each additional 50 or fraction thereof		Fee ($)	Fee Paid ($)
	- 100 =		/ 50 =		(round **up** to a whole number) x		= 0.00

4. OTHER FEE(S)

	Fees Paid ($)
Non-English Specification, $130 fee (no small entity discount)	
Other: Terminal Disclaimer	65.00

SUBMITTED BY

Signature	Stephen B. Schott	Registration No. (Attorney/Agent) 51,294	Telephone 215-568-6400
Name (Print/Type)	Stephen B. Schott		Date 12/29/2004

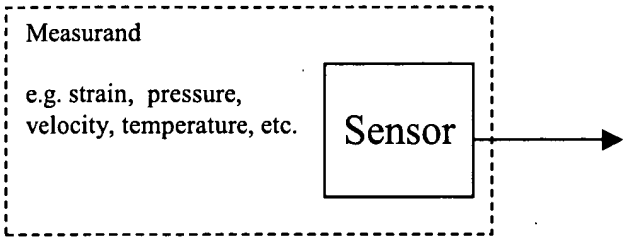
This collection of information is required by 37 CFR 1.136. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

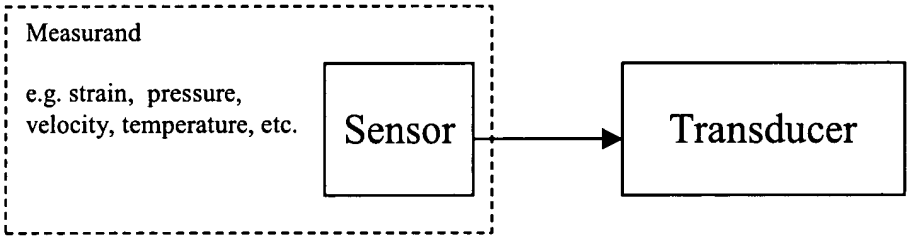
OIPE JC19
JAN 03 2005
PATENT & TRADEMARK OFFICE

Sensors and Transducers

Sensing Elements



Sensors are devices that detect the physical quantities (measurands) to be measured, based on some natural phenomena, and generate signals that can be manipulated by the element of the next stage.



Transducer is a device that detects input (the measurand) in one physical quantity and gives an output in a different physical quantity. The term transducer is also used in reference to a packaged device, which may contain a sensor, transducer, and some signal conditioning elements.

Sensors and transducers are often used interchangeably. The sensing element can extend our capacity to detect physical quantities, which can not be noticed by our human senses due to their subliminal nature or minuteness. The transducer element is used to convert the sensed physical quantity into an output signal that is in a different physical domain.

Sensors with mechanical arrangements are often used to acquire mechanical information. For example, the information on pressure can be collected using a bourdon tube, a diaphragm, or a bellow. They all work on the principle that the pressure acting on the sensing element would result in a force that causes deformation of the sensing element. Another example is the bimetallic strip. Two metal strips of different coefficients of thermal expansion are bonded together to form a bimetallic strip. The two strips would have different amounts of thermal deformation when the temperature of the assembly is changed. As a result, the strip will be deformed into an arc and the total displacement of the bimetallic strip out of the plane of the assembly indicates the amount of temperature change. Other physical arrangements like orifice plate and venturi tube senses the fluid flow rate by detecting the differential pressure across a known sectional flow area.

Transducers normally have electrical signal outputs and can be divided into two general classes: **active** and **passive** transducers. Active transducer does not need an external power supply while passive transducer demands such a power supply in order to give a voltage or current output signal. Passive transducers can be classified into resistive, inductive and capacitive types. Active transducer may generate an electrical output when it detects the measurand.

In a resistive transducer, the resistance changes in response to the value of the physical quantity (measurand) being measured. Potentiometer is an example of resistive transducers because the resistance changes as the position of the tapping point is being varied. Strain gauge is another example as its resistance changes with the amount of strain it experiences. Resistance temperature detector (RTD) is a metallic element that changes its resistance with temperature. Thermistor is a thermally sensitive ceramic semi-conductor that changes its resistance with the body temperature.

Inductive transducers are widely used in industrial applications because they are robust and compact. In an inductive transducer, the inductance of the transducer would change with respect to the change in the measurand. If the transducer is made up of one single conductor, then the inductance is referred to as self-inductance; while the variation of mutual inductance is considered if the transducer consists of two or more conductors. Some of the inductive transducers also work on the principle of eddy currents.

Capacitive transducers are also widely used in industrial and scientific applications. Their capacitance changes in response to the variation in the measurand. For example, in a capacitive microphone, the variation of the spacing between the plates in response to the different sound pressures would result in a change in the capacitance of the microphone. Capacitive transducers are also used to measure displacements, liquid levels, humidity and moisture, etc.

Thermoelectric active transducers work on the principles of Seebeck, Peltier and Thomson effects. The Seebeck effect is the physical phenomenon that explains how the thermal energy is being converted into electrical energy. The Peltier and Thomson effects are current-dependent, they explain how heat is being transported by an electric current. The Seebeck effect is the phenomenon that a net source electromotive force (known as absolute Seebeck emf) arises between a pair of points in an individual electrically conducting material if these points are at different temperatures. This is the principle of operation for thermocouples. A thermocouple is a circuit in which a closed loop is formed by joining the ends of two strips of dissimilar metals and the two junctions of the metals are at different temperatures. Peltier effect is the phenomenon that if a current passes through a thermocouple, the temperature of one junction increases and the temperature of the other decreases. This indicates that heat is transferred from one junction to the other. Thomson effect is the phenomenon that if a temperature difference exists between any two points of a current-carrying conductor, heat is either expelled or absorbed depending upon the material and the direction of both the electric current and temperature gradient. Examples of thermocouple materials include: chromel/constantan used for a type E thermocouple, iron/constantan for a type J thermocouple, chromel/alumel for a type K thermocouple, etc.

Another common type of active transducers is piezoelectric transducer. Piezoelectric material will develop an electric charge if it is being deformed. Piezoelectric material also exhibits a reversible effect: it will deform in response to an applied electric field. Materials such as quartz (crystalline SiO_2), lithium niobate ($LiNbO_3$) and lithium tantalate ($LiTaO_3$) are examples of single-crystal materials that possess piezoelectricity. Non-single-crystal piezoelectric materials include piezoelectric ceramics, piezoelectric polymers, and composites of piezoelectric ceramics with inactive polymers. Perovskites are commonly used piezoelectric ceramics, examples include barium titanate ($BaTiO_3$), lead titanate ($PbTiO_3$), lead zirconate titanate ($PbZrTiO_3$ or PZT) and lead magnesium niobate ($PbMg_{1/3}Nb_{2/3}O_3$ or PMN). An example of piezoelectric polymers is polyvinylidene fluoride (PVDF).

Other active transducers may operate on the principles of photoelectric effects such as photoemissive effect, photoconductive effect and photovoltaic effect. Photoemissive effect is the phenomenon that electrons will be released when radiation with a wavelength less than a critical value is hitting a metal surface. Pure metals are rarely used in photoemissive transducers. A photoemissive transducer normally has an alkali metal cathode, which will release an electron when a light beam strikes it. The released electron will hit the anode, thus generating a measurable current. An example of the alkali metals used is NaKCsSb (also known as S20). The photoecathode can also be made of negative electron affinity (NEA) material such as gallium arsenide (GaAs).

Photoconductive transducer will have its resistance changed in response to the variation in the light intensity. Photoconduction is found in amorphous, polycrystalline, and single-crystalline materials. Cadmium sulphide (CdS), lead sulphide (PdS), lead selenide (PbSe), indium antimonide (InSb) and mercury cadmium telluride (HgCdTe) are examples of photoconductive materials.

Photovoltaic transducer generates an output voltage in response to the incident light. The voltage generated normally varies logarithmically with light. Solar cell is an example of such a transducer and is basically a p-n junction detector. Examples of photovoltaic materials include cadmium tellurium (CdTe), amorphous silicon (aSi), poly crystal silicon (pSi), selenium (Se), etc.

Further Reading

Chapter 2, Section 2.2 of "Introduction to Engineering Experimentation"
Chapter 3 of "Principles of Measurement and Instrumentation"
Chapters 1 & 2, "Sensors and Control Systems in Manufacturing", Sabrie Soloman, McGraw-Hill, 1994. (PolyU Library Call No. TS158.6 .S55 1994)